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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/624,537	07/23/2003	Katsuhiro Horikawa	M1071.1855/P1855	6662

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EXAMINER	
MAYES, MELVIN C	

ART UNIT	PAPER NUMBER
1734	

DATE MAILED: 01/21/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

LD

Office Action Summary	Application No.	Applicant(s)	
	10/624,537	HORIKAWA ET AL.	
	Examiner	Art Unit	
	Melvin Curtis Mayes	1734	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-20 is/are pending in the application.

4a) Of the above claim(s) 18-20 is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-17 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 7/23/03.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

(1)

Applicant's election with traverse of Claims 1-17 in the reply filed on October 29, 2004 is acknowledged. The traversal is on the ground(s) that no evidence is provided that the product can be made by another process and the first four pages of the specification are to the contrary. This is not found persuasive because, as set forth in the restriction requirement, the product can be made by sintering in air or atmosphere of majority oxygen. The method requires sintering in an atmosphere of oxygen concentration of 5% by volume of less but more than 0%, apparently to suppress reduction in piezoelectric d constant (specification, pg. 5). This particular sintering is not required for the product as claimed.

The requirement is still deemed proper and is therefore made FINAL.

Specification

(2)

The disclosure is objected to because of the following informalities: page 5 is partly illegible and should be resubmitted or amended.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

(3)

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

(4)

Claims 12 and 13 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claims 12 and 13 claim that the thickness of "the layers" after sintering is 64 um or 40 um or less. Does this refer to the ceramic layers or electrode layers? For examination, the claims are being interpreted as "the layers" referring to the ceramic layers.

Claim Rejections - 35 USC § 103

(5)

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

(6)

Claims 1-5, 7 and 14-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Randall et al. 2002/0079622 in view of Ponomarev et al. 2004/0012000 and Horikawa et al.6,383,408.

Randall et al. disclose a method of making a cofired multilayered piezoelectric material such as an actuator or transformer comprising: forming a green body assembly of alternating layers of piezoelectric ceramic, such as PZT, and copper electrode layers; debinding; and co-sintering in an atmosphere of oxygen partial pressure of 10^{-3} to 10^{-10} atms [0025]-[0027]. Randall et al. do not disclose providing the piezoelectric PZT ceramic as one having a molar quantity of Pb reduced by 0.5-5 mol% from that of stoichiometric composition.

Ponomarev et al. teach that to achieve high efficiency under dynamic operations such as in a multilayer piezoelectric ceramic transformer, low-loss hard piezoelectric ceramic materials are required [0002].

Horikawa et al. teach that a piezoelectric ceramic which has significantly low loss is a composition represented by the formula $Pb_x\{(Mn_aNb_b)_yTi_zZr_{(1-y-z)}\}O_3$,where on a molar basis $0.95 \leq x \leq 0.995$ (col. 2,lines 44-56). When the amount of Pb is decreased below stoichiometric content, no foreign phase exist in the sintered material, and hence a piezoelectric ceramic having an even lower loss can be obtained (col. 3, lines 14-18)

It would have been obvious to one of ordinary skill in the art to have modified the method of Randall et al. for making a cofired multilayered piezoelectric actuator or transformer by providing the piezoelectric ceramic as a PZT ceramic having the composition formula $Pb_x\{(Mn_aNb_b)_yTi_zZr_{(1-y-z)}\}O_3$,where on a molar basis $0.95 \leq x \leq 0.995$, as taught by Horikawa et al., a piezoelectric ceramic which has significantly low loss because of Pb content decreased below stoichiometric content, as Ponomarev et al. teach that low loss piezoelectric ceramic material are required for piezoelectric ceramic transformers. Providing the PZT ceramic of the composition having Pb (A site component) of molar quantity reduced by 0.5-5 mol%, as claimed, would have been obvious to one of ordinary skill in the art, as Horikawa et al. teach that such a composition has low loss and as Ponomarev et al. teach that low loss is desired for multilayer piezoelectric ceramic transformers.

By co-sintering in an atmosphere of oxygen partial pressure of 10^{-3} to 10^{-10} atms as disclosed by Randall et al., the green body is obviously sintered in an atmosphere encompassed by or encompassing atmosphere of oxygen concentration of 5 vol% or less but more than 0 vol% as claimed.

By providing the piezoelectric ceramic of composition $Pb_x\{(Mn_aNb_b)_yTi_zZr_{(1-y-z)}\}O_3$, the average valence of the B site component is greater than stoichiometric and greater than 4.000 but

less than 4.100, as claimed in Claims 2, 3 and 14, and the B site component comprises Nb, as claimed in Claims 5, 7 and 15.

(7)

Claims 1-5, 7-11 and 14-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Horikawa 6,080,328 in view of Ponomarev et al. 2004/0012000, Horikawa et al.6,383,408 and JP 11-163433.

Horikawa '328 discloses a method of making a piezoelectric ceramic element comprising: providing a piezoelectric ceramic of the formula $Pb_a[(Cr_xNb_{(1-x)})yZr_{(1-b-y)}Ti_b]O_3$, wherein $0.95 \leq a \leq 1.05$; producing green sheets; laminating green sheets with internal electrodes; and firing. Green sheets of thickness of 60-100 um can be coated with electrode paste of Ag/Pd of ratio 7/3 (col. 2, lines 39-67, col. 8, lines 5-35). Horikawa does not disclose limiting the Pb in the composition to molar quantity reduced by 0.5-5 mol% from that of stoichiometric composition or disclose firing (sintering) in an atmosphere of oxygen concentration of 5 vol% or less but more than 0 vol%.

Ponomarev et al. teach that to achieve high efficiency under dynamic operations such as in a multilayer piezoelectric ceramic transformer, low-loss hard piezoelectric ceramic materials are required [0002].

Horikawa et al. teach that a piezoelectric ceramic which has significantly low loss is a composition represented by the formula $Pb_x\{(Mn_aNb_b)_yTi_zZr_{(1-y-z)}\}O_3$,where on a molar basis $0.95 \leq x \leq 0.995$ (col. 2,lines 44-56). When the amount of Pb is decreased below stoichiometric content, no foreign phase exist in the sintered material, and hence a piezoelectric ceramic having an even lower loss can be obtained (col. 3, lines 14-18)

JP 11-163433 teaches that in making a piezoelectric transducer having Ag electrodes, diffusion of the Ag into the ceramic is reduced to 10-50 ppm by sintering in an oxygen density of 1-10% (computer translation [0029]).

It would have been obvious to one of ordinary skill in the art to have modified the method of Horikawa '328 for making a piezoelectric ceramic element by limiting the limiting the Pb in the composition to molar quantity reduced by 0.5-5 mol% ($0.95 \leq a \leq 0.995$) from that of stoichiometric composition, as Horikawa et al. teach that such a composition has low loss because of Pb content decreased below stoichiometric content and as Ponomarev et al. teach that low loss is desired for multilayer piezoelectric ceramic elements. Limiting the Pb molar quantity as claimed would have been obvious to one of ordinary skill in the art to achieve lower loss, taught by Ponomarev et al. as desired for multilayer piezoelectric ceramic elements.

It would have been obvious to one of ordinary skill in the art to have further modified the method of Horikawa '328 by firing (sintering) the laminate in an oxygen atmosphere in the range of 1-10% oxygen density, as taught by JP '433, to reduce diffusion of the Ag into the piezoelectric ceramic. Sintering in an oxygen atmosphere of oxygen concentration in the range of up to 5 vol%, as claimed, would have been obvious to one of ordinary skill in the art as encompassed by the range of 1-10% taught by JP '433 to reduce diffusion.

By providing the piezoelectric ceramic of composition $Pb_a[(Cr_xNb_{(1-x)})yZr_{(1-b-y)}Ti_b]O_3$, the average valence of the B site component is greater than stoichiometric and greater than 4.000 but less than 4.100, as claimed in Claims 2, 3 and 14, and the B site component comprises Nb and Cr, as claimed in Claims 5, 7, 8 and 15.

(8)

Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over the references as applied to claim 4 above, and further in view of Feltz et al. 2002/0098333.

Feltz et al. teach that in piezoelectric ceramic, partial substitution of the quadrivalent cations Zr and Ti on the B-positions can be by a combination of two-valent metal cations such as Ni and quinvalent metal cations such as Nb [0020].

It would have been obvious to one of ordinary skill in the art to have further provided Ni in addition to the Nb, as taught by Feltz et al., as metal cation that can be provided with Nb for partial substitution of Zr and Ti in piezoelectric ceramic. Providing Nb and Ni as part of the B-site component in partial substitution of Zr and Ti would have been obvious to one of ordinary skill in the art, as taught by Feltz et al.

(9)

Claims 12 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over the references as applied to claim 11 above, and further in view of JP 2001-181035.

Horikawa '328 discloses firing at a temperature of 1100°C or less.

JP '035 teaches that in making a piezoelectric ceramic transducer, etc, if the burning temperature is made low, it is possible to use cheaper silver-palladium alloy as the internal electrode. To lower manufacturing cost, it is desirable to make the percentage of palladium be 20% or less, which can be used with a burning temperature of 1000°C or less (computer translation [0004]).

It would have been obvious to one of ordinary skill in the art to have modified the method of the references as combined by coating the green sheets with Ag/Pd paste of at least

80% or 85% Ag, as taught by JP '035, to lower manufacturing costs by using cheaper Ag/Pd alloy. The use of an Ag/Pd paste of ration of at least 80/20 or 85/15 would have been obvious to one of ordinary skill in the art to lower the manufacturing cost by using a cheaper Ag/Pd alloy.

By producing green sheets of thickness of 60-100 um, piezoelectric layers of thickness less than 64 um or 40 um after sintering are obviously provided.

Conclusion

(10)

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

(11)

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Melvin Curtis Mayes whose telephone number is 571-272-1234. The examiner can normally be reached on Mon-Fri 7:30 AM - 4:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Chris Fiorilla can be reached on 571-272-1187. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Melvin Curtis Mayes
Primary Examiner
Art Unit 1734

MCM
January 14, 2005